PB83-181156

EPA Evaluation of the Freedom Products Hot Tip Device under Section 511 of the Motor Vehicle Information and Cost Savings Act

(U.S.) Environmental Protection Agency
Ann Arbor, MI

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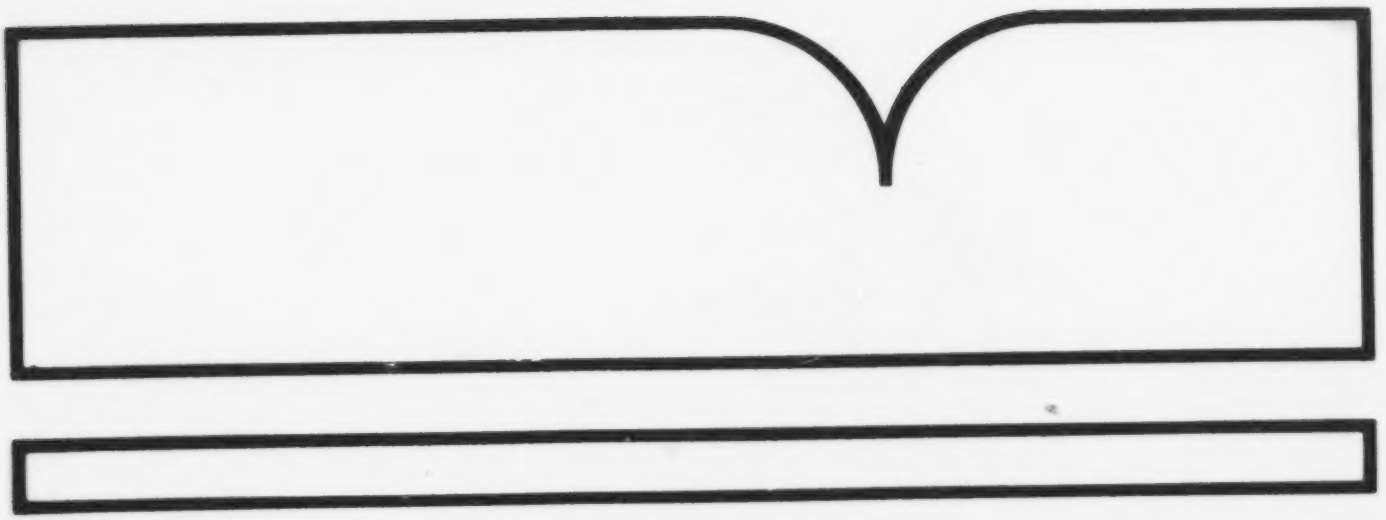

U.S. Department of Commerce
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EPA-AA-TEB-511-82-16

EPA Evaluation of the Freedom Products Hot Tip Device Under Section 511 of the Motor Vehicle Information and Cost Savings Act

by

Edward Anthony Barth

September 1982

Test and Evaluation Branch
Emission Control Technology Divison
Office of Mobile Sources
U.S. Environmental Protection Agency

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15. SUPPLEMENTARY NOTES

16. ABSTRACT

This document announces the conclusions of the EPA evaluation of the Freedom Products Hot Tip device under the provisions of Section 511 of the Motor Vehicle Information and Cost Savings Act.

The evaluation of the "Freedom Products Hot Tip" device was conducted upon the application of the marketer of the device. This device is claimed to reduce emissions and improve fuel economy. The device is a heated idle mixture screw which incorporates an air bleed. The device is claimed to improve the preparation of the fuel/air mixture and thereby improve fuel economy and performance.

EPA fully considered all of the information submitted by the applicant. The evaluation of the "Freedom Products Hot Tip" device was based on that information and EPA's engineering judgement. The information supplied by the applicant was insufficient to adequately substantiate either the emissions or fuel economy benefits claimed for the device. EPA is unaware of any data that demonstrates that replacing the idle mixture screw with a heated screw incorporating an air bleed will significantly affect the operation of the vehicle. Thus, there is no reason to believe that the use of the "Freedom Products Hot Tip" will benefit emissions or fuel economy of motor vehicles.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Automobiles Fuel Consumption Exhaust Emissions Tests	Air bleed device Fuel Economy Gas Saving Device	

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EPA Evaluation of the Freedom Products Hot Tip Device Under Section 511 of the Motor Vehicle Information and Cost Savings Act

The Motor Vehicle Information and Cost Savings Act requires that EPA evaluate fuel economy retrofit devices and publish a summary of each evaluation in the Federal Register.

EPA evaluations are originated upon the application of any manufacturer of a retrofit device, upon the request of the Federal Trade Commission, or upon the motion of the EPA Administrator. These studies are designed to determine whether the retrofit device increases fuel economy and to determine whether the representations made with respect to the device are accurate. The results of such studies are set forth in a series of reports, of which this is one.

The evaluation of the "Freedom Products Hot Tip" device was conducted upon the application of the marketer of the device. This device is claimed to reduce emissions and improve fuel economy. The device is a heated idle mixture screw which incorporates an air bleed. The device is claimed to improve the preparation of the fuel/air mixture and thereby improve fuel economy and performance.

The following is a summary of the information on the device as supplied by the Applicant and the resulting EPA analysis and conclusions.

1. Title:

   Application for Evaluation of the Freedom Products Hot Tip Under Section 511 of the Motor Vehicle Information and Cost Savings Act

2. Identification Information:

   a. Marketing Identification of the Product:

      Freedom Products Hot Tip

   b. Inventor and Patent Protection:

      "See Appendix 1 - Copy of Patent." This patent, provided with the application, described an earlier device and was submitted for background information purposes only. Therefore, it is not included in the attachments.

   c. Applicant:

      (1) Freedom Products Inc.
      P.O. Box 700
      Freedom, CA 95019

(2) Principals

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Ollie and Renee Schiavon
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Watsonville, CA 95076

Jack Passey, Jr.
425 Hecker Pass Rd.
Watsonville, CA 95076

(3) Jack Passey, Jr. is authorized to represent Freedom Products Inc. in communication with EPA.

d. Manufacturer of the Product:

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Salinas, CA 93908

(2) Principals

C.E. Pittenger, Owner, Pittenger Industries

3. Description of Product (as supplied by Applicant):

a. Purpose:

"The purpose of the Hot Tip is to provide a method of reducing vehicle emissions and engine wear by effecting a more efficient, smoother running engine. The Hot Tip keeps fuel consumption to a minimum, and hence conserves energy."

b. Theory of Operation:

"The Hot Tip provides a method of reducing vehicle emissions by introducing a controlled amount of heated air into the idling circuit of the engine carburetor. The Hot Tip is designed to replace the carburetor volume control [idle mixture] screw, for the purpose of pre-heating the fuel and air mixture. Normally, as the air and fuel mixture pass through the carburetor, they create a refrigerating action [that] obstructs the idling orifice, and the engine stalls. The Hot Tip de-ices this orifice, which results in smooth idling performance. The fuel is more readily vaporized, and the fuel mixture is more stable. The total effect is a smooth-running engine where choking is at a minimum, which makes improved vaporization and keeps fuel consumption to a minimum."

c. Construction and Operation:

"See Appendix II" Appendix II of the application was a detailed description of the device construction and operation. Subsequently, a revised version was submitted (Attachment A). Therefore, Appendix II no longer applies and it is not included as an attachment.

4. Product Installation, Operation, Safety and Maintenance (as supplied by Applicant):

a. Applicability:

"This device applies to all 1978 and older automobiles with carburetors which have an idle adjustment screw, or screws, and all 1979 and newer automobiles with carburetors that do not have a sealed idle adjustment screw."

b. Installation - Instructions, Equipment, and Skills Required:

"Step 1: Before taking out your carburetor's idle adjustment screw, turn it all the way into its closed position, very carefully counting the turns and parts of turns to do so. It can then be taken out.

"Step 2: Next, screw the brass needle into the female end of the Hot Tip to approximately the length of the idle adjustment screw you just took from your carburetor. Now tighten jamb nut firmly to hot tip barrel. IMPORTANT: Grip barrel only on crimped ends.

"Step 3: Hot Tip unit can now be installed in carburetor, after first placing the coil tension spring you took from the idle screw onto the brass needle. If you find the needle is too long, either stretch the tension spring or trim the needle at thread end. Turn Hot Tip to full closed position, before backing-off the same number of turns and parts of turns counted before you took out the idle screw.

"Step 4: Hot Tip is now ready to set. With engine warmed up and at idle with choke off, adjust needle in until engine nearly dies, then back off slowly until engine barely smoothes, then stop. IMPORTANT: Do not reset needle after energizing without using pliers as it becomes very hot.

NOTE: With two-barrel carburetors, which require two Hot-Tips, it is best to install and set each Hot Tip in turn before proceeding to the next step.

"Step 5: Hook-up must be made through ignition circuit in your car's fuse box, so that heater operates only when key is on and at all the time the engine is running. Most cars have a spare spade fitting in the fuse box, which is located under the dash. If one is not available, attach a brass spade to the wire and fit under the metal end of a fuse. IMPORTANT: Before harness hook-up, remove fuse from harness line, remembering to replace it after hook-up has been made."

c. Operation:

"Operation is automatic with [the] ignition of [the] engine."

d. Effects on Vehicle Safety:

"None"

e. Maintenance:

"None"

5. Effects on Regulated Emissions and Fuel Economy (submitted by Applicant):

"See Appendix III" Appendix III is Attachment B of this evaluation.

6. Analysis

a. Identification Information:

(1) Marketing Identification:

The application and supplemental information (Attachment C) described several different variations of a heated idle mixture screw. After several letters (Attachments D, E, and F) and phone calls, the description and marketing status of these versions was determined to be:

(a) Freedom Products Hot Tip described in Appendix II of application. This heated needle incorporated a long internal air bleed with undercut threads providing a short external air bleed. The application no longer applies to this model.

(b) The model identified as 'preferred needle B' in the Attachment C. This heated needle incorporated only a long internal air bleed. This is the version that was finally identified as the only model to which the application applied.

(c) Preferred needle B with a water vapor air bleed. The long internal air bleed was to be connected to a water vapor bottle as shown in Attachment C. The application did not cover this model.

(d) The model identified as 'modified needle C' in Attachment C. This heated needle incorporated a short internal air bleed and check valve.

"Modified Needle C with the check valve was submitted to California Air Resources Board. Its purpose was to prevent the bleed back of vapors. The A.R.B. denied us an exemption because it admits particulates from the atmosphere into the engine. It is also more cumbersome to install so we have rejected it." Attachment E.

(e) The model identified as needle D in Attachment C. This heated needle incorporated a short internal air bleed.

"Needle D with the short internal air bleed is the style that was used for testing to check the feasibility of using an air bleed. It is not to be considered in future testing or marketing." Attachment E.

(f) The model identified as Freedom Products Jet Heater in Attachment C. The application did not apply to this model.

"Freedom Products Jet Heater does not, as you have noted, have an air bleed. It is the device that we have, California Air Resources Board exemption #D109 on at present. We have sold these in California. The "B" needle works about 50% better and we would like to replace the solid needle with it which is the reason for this application." Attachment E.

(2) Inventor and Patent Protection:

The patent covered the Jet Heater heated idle mixture screw (no air bleed) and was provided as Appendix I of the application for background purposes only (see Section 6a(1)). Appendix II of the application was verbally identified by the applicant as the new patent application for the device being evaluated but was later superseded by a new patent application (Attachment A).

b. Description:

(1) As stated in Section 3a, the primary purpose of the Hot Tip is to reduce engine wear and vehicle emissions by using a device to improve the combustion process. This is in agreement with the theory of operation given in Section 3b. That is, the device is claimed to improve the quality of the fuel passing through the carburetor mixture circuit by heating the fuel and introducing a controlled amount of heated air.

(2) The theory of operation given in Section 3b describes a system that will heat the small amount of fuel passing the idle mixture screw and will introduce heated air into this fuel. However, replacing the idle mixture screw with a heated screw that has an air-bleed does not guarantee an improvement in emissions or fuel economy. The amount of fuel and air heated is relatively small compared to the normal flow of fuel and air through the carburetor. Therefore, any change in the mixture circuit may have little overall effect on emissions or fuel economy when driving. Also, a vehicle's induction system may already perform efficiently and thus no change would be noted.

The statements in Section 3b about carburetor icing are misleading. Carburetor icing normally occurs at temperatures near 32°F. However, icing is no longer the problem it was formerly. The icing problems were solved by a combination of fuel and vehicle changes. The refineries now use additives to alleviate the icing. The manufacturers now heat the carburetor base and inducted air.

Also, the brief description of the phenomenom by the applicant, does not clearly describe how and why icing is a problem. Icing is caused by the cooling effect of the air-fuel mixture in the venturi. This, in turn, causes an ice build up near the throttle blade and idle ports. Under these conditions, the engine may provide sufficient power for driving yet stall when idling. If icing is a problem, the device may remove the ice at the idle port, however, it may not remove the ice obstructing the throttle blade.

(3) The description of the device provided with the application was superseded by a new description, Attachment E. This patent description adequately described the device being evaluated. The description given of the water vapor air bleed version adequately described the construction of this version but did not adequately indicate how the proper liquid level in the water vapor bottle would be determined. This is critical since the flow of heated air through the idle mixture screw would be strongly influenced by the depth of the air inlet tube (item 76 of figure 1 of the patent application) below the surface of the water.

Also, because there are several different configurations of the idle mixture screws used in vehicle carburetors (various screw diameters and thread pitches), EPA requested information on how they met this problem (Attachment D). The response of the applicant* adequately describes a practical approach that allows him to market only one basic Hot Tip model that is able to fit many different vehicles. However, the marketing identification of these various adapter needles was not given.

(4) No emission or fuel economy claims for the device were made in the application. Following is the response to an EPA request (Attachment D) for specific claims:

> "The reduction in emissions and improvement in fuel economy have varied depending on the condition of the engine and especially the carburetor. Individual driving habits are also a factor. On cars without serious problems we have dropped emissions from 25% to 75%. Mileage increases have been from very little to 20%." This statement was part of Attachment E.

(5) No cost data was provided with the application. In response to EPA verbal and written requests (Attachment D), the applicant stated the cost would be $59.95 plus $20.00 for installation (Attachment C). This was later changed to $79.95 plus $20.00 for installation (Attachment E). As noted in Section 6c(2), because of the skills and equipment required, installation and adjustment must be done by a qualified mechanic.

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* "The application does not distinguish between SAE and metric screw threads because the heater units all have the same 10-32 internal threads. The needles all have the same threads on the shank that screws into the heater and is locked in place with a lock nut, but the body of the needle that goes into the carburetor may have many different sizes, shapes and threads. They are identified by the model of the carburetor in which they are to be installed. We presently have needles to cover the more popular Carter, Ford and Rochester carburetors as well as the most common Japanese carburetors. We are working on Holley and have developed one main needle at present for it, with additional ones to be added." See Attachment E.

c. Installation, Operation, Safety and Maintenance:

(1) Applicability:

The applicability of the product, as stated in the Section 4a, to essentially all carbureted gasoline powered vehicles with unsealed idle mixture screws is judged to be correct.

However, the device applies to few late model vehicles. Beginning with the 1979 model year, most GM vehicles have had sealed idle mixture screws. And, beginning with the 1981 model year, virtually all vehicles have had sealed idle mixture screws.

(2) Installation - Instructions, Equipment and Skills Required:

The installation instructions, Section 4b were omitted from the application and were provided later, Attachment C. Since other information provided indicated that some adjustment of the flow of the heated bleed air was required, EPA requested clarification (Attachment D). In response (Attachment E), the applicant stated that no adjustment of the bleed air was required.

Although the instructions imply that the device could be installed by a person with average mechanical skills, simple hand tools, and the vehicle wiring diagrams, the later statements about the device installation* show that proper installation and adjustment will need to be performed by a skilled mechanic who is familar with the device and has access to specialized shop equipment. The instructions did not state how this adjustment should be done using the infrared equipment.

The estimate of one man hour for installation is judged to be reasonable.

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*"I believe the device should be sold through qualified shops since the best results are obtained when infrared equipment is used for adjusting the needles. It is not impossible for good mechanics to install them by "ear", but I don't believe the average "back yard" mechanic could achieve maximum benefits. Therefore, I prefer to see them installed with the use of equipment. It is also extremely beneficial to check the air cleaner, to make sure the carburetor float is set correctly, and to check to see that the ignition system is in order. The infra-red machine can give an immediate clue if the carburetor float is not operating correctly." This statement is contained in Attachment E

(3) Operation

Although the device will function automatically as claimed, it may adversely affect vehicle operation. The device draws appreciable power (2.5 amps, 35 watts). Depending on how the device is installed in the ignition circuit, the added current may overload the wiring. These problems will be more acute if two Hot Tips are required (four venturi and most two venturi carburetors).

Note: Although an additional wiring harness is provided with the device, the installation instructions require the device to be electrically connected through the ignition circuit.

(4) Effects on Vehicle Safety:

Based on the description in the patent application and the installation instructions, the device is judged to be capable of being fabricated to be safe in normal vehicle usage. However, the additional electrical load on the ignition circuit may be too high for the wiring, especially if two Hot Tips are required.

(5) Maintenance:

The applicant's statement that no maintenance is required is judged to be correct. However, the device, additional wiring, and added electrical connectors would require the normal periodic inspections accorded similar components in the vehicle.

d. Effects on Emissions and Fuel Economy:

(1) Unregulated Emissions:

The applicant submitted no test data and made no claims regarding unregulated emissions. The statements and data supplied in Section 5 relate to regulated emissions and fuel economy only. However, since the device does not modify the vehicle's combustion process or powertrain, the device is not expected to significantly affect a vehicle's unregulated emissions.

(2) Regulated Emissions and Fuel Economy:

The applicant did not submit test data in accordance with the Federal Test Procedure and the Highway Fuel Economy Test for the version of the device being evaluated.* These two test procedures are the primary ones recognized by EPA for evaluation of fuel economy and emissions for light duty vehicles.** After numerous telephone and written requests (Attachments F, G, and H) were made over a period of several months in attempts to coordinate the testing of the Freedom Products Hot Tip, the applicant still had not set up a test program. Because of the inordinate amount of time that had passed since EPA first received the application it was finally necessary to conclude the evaluation without waiting for this test data. The applicant was so informed with the invitation to reapply for an EPA evaluation once he obtained the required test data.

As noted in Section 6b(2), EPA is unaware of any information that provides a technical basis to support the claim for improved emissions or fuel economy for a heated idle mixture screw incorporating an air bleed. Therefore, in the absence of supporting technical information or supporting test data, EPA concluded that the information provided did not support the claims for the device and that it would have no beneficial effect on either emissions or fuel economy.

7. Conclusions

EPA fully considered all of the information submitted by the applicant. The evaluation of the Freedom Products Hot Tip device was based on that information and our engineering judgement.

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*The applicant did submit test data on the Jet Heater (Attachment B). This is an earlier version of the device that does not have an air bleed. This data did not show a statistically significant improvement in either emissions or fuel economy.

**The requirement for test data following these procedures is stated in the policy documents that EPA sends to each potential applicant. EPA requires duplicate test sequences before and after installation of the device on a minimum of two vehicles. A test sequence consists of a cold start FTP plus a HFET or, as a simplified alternative, a hot start LA-4 plus a HFET. Other data which have been collected in accordance with other standardized procedures are acceptable as supplemental data in EPA's preliminary evaluation of a device.

The information supplied by the applicant was insufficient to adequately substantiate either the emissions or fuel economy benefits claimed for the device.

EPA is unaware of any data that demonstrates that replacing the idle mixture screw with a heated screw incorporating an air bleed will significantly affect the operation of the vehicle. Thus, there is no reason to believe that the use of the Freedom Products Hot Tip will benefit emissions or fuel economy.

FOR FURTHER INFORMATION CONTACT: Merrill W. Korth, Emission Control Technology Division, Office of Mobile Sources, Environmental Protection Agency, 2565 Plymouth Road, Ann Arbor, Michigan 48105, (313) 668-4299.

List of Attachments

Attachment A	Patent Application. Provided as part of Attachment E.
Attachment B	Appendix III of application - Letter of September 4, 1981 from Gary Leonhardt of Systems Control Inc. to Jack Passey of Freedom Products Inc. providing test results of the Jet Heater.
Attachment C	Letter of January 4, 1982 from Jack Passey of Freedom Products Inc. to EPA responding to EPA telephone request for claims for device, cost, drawings, installation instructions, and missing page of application.
Attachemnt D	Letter of January 19, 1982 from EPA to Jack Passey, Jr. of Freedom Products Inc. requesting additional information about the device and clarification of previously submitted information.
Attachment E	Letter of February 19, 1982 from Jack Passey, Jr. of Freedom Products Inc. responding to EPA request of January 19, 1982 and providing copy of new patent application.
Attachment F	Letter of March 9, 1982 from EPA to Mr. Jack Passey, Jr. of Freedom Products Inc. confirming telephone conversation of February 24, 1982 and providing a suggested test plan.
Attachment G	Letter of April 12, 1982 from EPA to Mr. Jack Passey, Jr. of Freedom Products Inc. requesting information and current status of test program of applicant.
Attachment H	Letter of May 27, 1982 from EPA to Mr. Jack Passey, Jr. of Freedom Products Inc. setting deadline for test results for the Hot Tip.

Docket No. CT-500

S P E C I F I C A T I O N

HEATED AIR BLEED IDLE NEEDLE

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BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to gas and liquid contact apparatus and more particularly to a heated, air bleed idle jet needle for an internal combustion engine carburetor.

Description of Prior Art

Whitmore et al 3,215,417, November 2, 1965, discloses a carburetor idle valve heater wherein the inner end of a tubular metal housing is connected to a solid idle needle valve and the housing contains an electric heating coil for the valve. A battery connection is made to a plug in the outer end of the housing.

Kimmell 2,576,401, November 27, 1951 discloses an electric carburetor heater wherein fuel enters an outer container and passes through an enclosed percolating container. Energization of the starter motor circuit causes a resistor in the percolating container to boil fuel therein and eject the fuel through sidewall orifices of a closed end tube and thence into the main jet of the carburetor. A resistance wire is wound around the tube and the resistance coil remains energized after the engine is started until the temperature of the incoming fuel rises high enough to open a thermostat switch. A heat insulating shield surrounds the coil.

Kwartz 2,723,339, November 8, 1955, discloses a fuel activator for carburetors wherein gasoline from the carburetor bowl flows down into an electrically heated cup-shaped receptacle and then flows up through a tube into a fixed, main fuel discharge jet for the carburetor throat or mixing chamber.

Eskew 2,846,989, August 12, 1958, discloses a carburetor de-icer wherein the carburetor needle valve has a bore that is connected to one end of a tube by a coupling nut incorporating a sealing ferrule. The other end of the tube admits heated air to an air heater box mounted on the exhaust manifold of the engine.

Schlichtling 3,077,341, February 12, 1963, discloses an air bleed idle needle valve wherein an air bleed inlet check valve is opened by high vacuum with the throttle closed to lean the idle mixture. Another air inlet port is opened by a thermostatic valve during hot weather.

Probst 3,557,763, January 26, 1971, discloses a system for inducting the vapor of a water-methanol solution into a port provided in the inlet manifold of an internal combustion engine, the port being for the connection of accessories. The vapor is drawn from a liquid vapor trap vessel having a metered air inlet tube.

Rock 3,865,907, February 11, 1975, discloses a system for bleeding air into the idle needle valve during normal operation and for injecting air and water vapor from a water reservoir vapor trap through the idle needle valve during acceleration by a spring advanced, vacuum retracted piston.

Kirmss, Jr. 3,275,922, April 8, 1975, discloses a vapor injection system for channeling an octane increasing vapor from a liquid reservoir through a passage in the idle adjustment screw. The air inlet to the reservoir is metered by a needle valve.

SUMMARY OF THE INVENTION

The heated, air bleed needle valve assembly of the present invention is an improvement in heated idle needle valves of the type disclosed in the aforesaid Whitmore et al patent 3,215,417.

An object of the present invention is to reduce exhaust emissions of pollutants such as carbon monoxide, hydro-carbons, etc. from an internal combustion engine and to decrease engine fuel consumption. These objects are accomplished by the installation of a heated idle needle valve which can be fitted to original equipment carburetors without modification of the carburetor and which can be adjusted after installation. Another object is to provide such a device which incorporates an air bleed passage and yet complies with both Federal and State emission standards or regulations relative to the escape of gasoline vapors from the carburetor to the atmosphere.

Experiments and engine testing with a commercial engine exhaust gas analyzer have shown that pollutant percentages in exhaust emissions can be reduced by substitution of an electrically heated idle jet needle, such as that shown in the aforesaid patent to Whitmore et al, for the original equipment needle. The Whitmore heated needle assembly is an elongate tubular device which can be substituted for the original equipment needle valve on most carburetors, even under the cramped and crowded conditions characteristic of modern engines. In the Whitmore et al device, an electric resistance wire heating coil element is disposed within a tubular metal housing

element and both elements are conductively connected to the idle needle valve for the carburetor. The needle valve serves as an electrical ground for one end of the heating coil. The vehicle battery is connected to an insulated plug on the other end of the coil. A circuit is completed through the coil and the coil heats the needle valve both directly and by heat conduction from the surrounding metal housing. The needle valve conducts a heat to the adjacent zone of the carburetor throat structure.

Raw gasoline, normally aspirated for idling when the throttle is substantially closed, is vaporized by the heated needle valve, thereby reducing pollutant emissions. Heating the needle valve and the adjacent carburetor body by conduction facilitates engine starting, particularly at low ambient temperatures.

It is contemplated that pollutant emissions and fuel consumption could be further reduced by admitting a correctly metered flow of air through a metering or air bleed jet formed in the aforesaid heated idle needle valve. Experiments were conducted by boring an air bleed passage of selected diameter axially through the needle valve, which passage communicated with the atmosphere and with the carburetor throat at the idle jet port therein. When such an air bleed passage is provided in a heated needle valve and when the passage is of the proper size for the engine, not only are emissions further reduced, but the total percent reduction in emissions exceeds the reduction which could be expected from the simultaneous employment of needle heating and of air bleed techniques. These results were displayed by various comparative control

tests of heated only, air bleed only, and heated air bleed idle needles, using a full size commercial "Sun" engine analyzer.

Although the addition of an air bleed passage to a heated idle needle valve, such as the needle valve of the aforesaid Whitmore et al patent, reduces pollutant admissions to an unexpected degree, the provision of an air bleed passage that is open to the atmosphere, could permit the escape of a very small volume of gasoline vapor when the engine is not running. In some jurisdictions, even this small fuel vapor escape could preclude official approval and certification of the device. Such fuel vapor escape could be prevented by connecting a liquid vapor trap to the air bleed inlet of an idle needle valve. However, the connection of a liquid vapor trap to an air bleed version of the Whitmore et al assembly does not provide an acceptable device.

Because of the interference, protrusion, overhang, etc., of carburetor and engine elements in the vicinity of the idle jet needle, the most accessible portion of a heated air-bleed needle assembly for selective connection of an air bleed inlet to a vapor trap is the outermost end portion of the assembly. This requires that the air inlet passage be provided in the outer plug that closes the outer end of the tubular housing, which plug must also be connected to the battery circuit. In the preferred assembly the outer plug is insulated from the tubular metallic housing to avoid short circuiting of the wire heating coil element through the housing and the grounded needle valve. The insulation extends along

the inner wall of the housing to preclude electrical contact of the resistance wire core with the housing. The insulation must withstand the heat from the wire coil and the preferred installation is formed as a braided fabric sleeve of fiberglass filaments or fibers.

When bleed air is drawn through the outer plug of a heated air bleed needle valve assembly having insulation of the character described, minute particles of glass fiber can be detached from the fibers forming the insulation sleeve. The air bleed passage in the needle valve is a small diameter metering passage, e.g. 0.020"-0.030", and unless dislodged insulation particles are drawn completely through the passage, that passage will become plugged by insulation particles after a relatively short period of operation. This is particularly true when the air bleed inlet of the assembly is connected (as by a rubber hose) to the air or vapor chamber of a water vapor trap. Water vapor drawn through the needle valve assembly housing will wet dislodged insulation particles, thereby causing the particles to form a paste-like mass which collects in the needle valve air bleed passage and soon obstructs or plugs it.

In the heated, air-bleed needle valve assembly of the present invention, plugging of the needle valve air bleed passage by insulation particles or the like is prevented by a small diameter, air conducting shield tube connected between the outer, air inlet plug and an inner plug that connects to the threaded air bleed needle valve. Thus, even if particles of insulation are dislodged within the tubular housing, they cannot be

drawn into the air bleed passage in the needle valve. Preferably, the shield tube is a thin walled metal tube having one end secured in one of the end plugs of the needle valve assembly by a light press fit. In order to insure that the electric heater coil provides the sole electrical connection between the outer and inner plugs of the assembly, the other end of the shield tube is electrically insulated from its associated plug. In the preferred embodiment of the invention, the aforesaid shield tube insulation is provided by fitting one end of the shield tube with a sleeve of insulating material which isolates the shield tube from the wall of the bore or socket formed in the associated plug for receiving the insulated end of the shield tube.

The heated air bleed idle needle valve assembly of the present invention is a universal device in that a single basic heated housing unit can selectively mount any one of an assortment of needle valves, custom designed for a selected carburetor. There are two basic variations in the specifications of various needle valves the adjustment thread diameter pitch and the optimum diameter of the air bleed passage. In accordance with the present invention, an assortment of different individual needle valves is provided to meet different specifications but the outer end of each needle valve is formed with a single standardized thread, e.g. a 10/32 thread. The inner plug of the assembly body is counter-bored and tapped to form a complementary, internally threaded socket. Thus, any selected needle valve of the assortment can be screwed to the outer plug of the assembly. The selected needle valve is secured by a locknut.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows an installation of a heated air bleed needle valve assembly connected to a liquid vapor trap, with parts in section.

Figure 2 is an enlarged section of the preferred needle valve assembly in the installation of Figure 1.

Figure 3 is a greatly enlarged fragmentary section of the carburetor end portion of the needle valve assembly

Figure 4 is an enlarged partial perspective of the insulated end of the shield tube.

Figure 5 is a section like that of Figure 2 showing a modified form of shield tube installation.

Figure 6 is a section like that of Figure 2 showing a modified form of shield tube.

Figures 7 and 8 are views of modified threaded idle needles.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Figure 1 shows a preferred idle needle valve assembly of the present invention fitted to an internal combustion engine carburetor and connected to an air bleed vapor trap.

The down draft carburetor C is bolted to the intake manifold M of an internal combustion engine in the usual manner. Installed on the carburetor is a heated air bleed idle needle valve assembly V of the present invention. The air bleed inlet of the needle V (to be described in detail presently) is connected by a flexible hose H to a liquid vapor trap T for preventing release of gasoline vapors within the carburetor to the atmosphere.

CARBURETOR

The body 10 of the carburetor C is flanged at 12 for attachment to a flange on the intake manifold M in the usual manner. The carburetor has the usual air inlet venturi 14 in a fuel mixture delivery throat 16. A main jet 18 supplies fuel to the venturi 14 from the carburetor bowl 20 in a manner well known in the art. During operation the flow of the mixture of fuel and air through the carburetor to an inlet port 22 in the inlet manifold is controlled by a throttle butterfly valve 24, in the usual manner.

The idle jet portion of the carburetor includes an idle jet orifice 28 opening into the throat 16 from an idle chamber 30 formed in a thickened carburetor body portion 32. The chamber 30 receives idling fuel from a passage 34 formed in the carburetor wall, which passage connects to a fuel delivery tube 36 extending into the carburetor bowl 20 in a conventional manner.

GENERAL DESCRIPTION OF NEEDLE VALVE ASSEMBLY

Referring to Figures 1 and 2, the major elements of the needle valve assembly V include a tubular metal housing 40 connected directly to an inner plug 42, which plug mounts the outer end portion of an air bleed idle needle N. The body of needle N is threaded at 44 and screwed into a complementarily threaded bore 46 in the carburetor wall portion 32. The inner end 50 of the needle N is conical to provide for manual adjustment of the effective size of the idle jet orifice 28 in the usual manner. A coil spring 51 maintains the adjustment. The needle N is formed with an air bleed passage P, to be described in detail presently.

In order to thoroughly vaporize the fuel drawn out of the idle jet orifice 28 during engine operation, the needle N is electrically heated by an electric resistance coil heating element E. The heating coil extends between the inner plug 42 and an outer plug 52 secured in the housing 40 and insulated therefrom by a sleeve S. The outer plug 52 has an air bleed passage formed therein, as will be described in detail presently.

Heating current is supplied to the resistance heating element E from the live terminal of the vehicle battery B (Fig. 1) via a line 54 controlled by a switch 56, which switch may operate in conjunction with the engine ignition switch (not shown). The line 54 has a connector clip 58 that connects to a nipple 60 (see Figure 2) projecting from the outer plug 52. When the switch 56 is closed, the circuit is completed from the live post of battery B, through the line 54, the outer plug 52, the heating element E, the inner plug 42, the needle N, the wall 32 of the carburetor C and ground.

In order to prevent plugging of an air bleed passage P in the needle N and in accordance with the present invention, a shield tube ST extends between the inner and outer plugs 42,52 and isolates air bleed vapor passing through the needle valve assembly V from the interior of the tubular housing 40 and the insulating sleeve S. The importance of the shield tube ST during vapor trap operation will be explained in detail subsequently.

VAPOR TRAP

In some jurisdictions the small volume of fuel

vapor that might escape from the air bleed passage P in the idle needle N, through the needle valve assembly V and to the atmosphere, represents an unacceptable emissio. In these jurisdictions, a liquid vapor trap T is installed and is connected by the hose H to the needle valve assembly V.

The nipple 60 projecting from the outer plug 52 of the needle valve assembly is formed to provide a terminal hose nipple structure 62 (see Figure 2) for receiving one end of the hose H leading from the vapor trap T.

The vapor trap T permits bleeding of the atmospheric air into the carburetor idle jet during engine operation while trapping any fuel vapor that might otherwise be emitted from the air bleed passage when the engine is not running. The vapor trap includes a water reservoir, preferably in the form of a plastic container or bottle 70 (Figure 1). The bottle 70 has a threaded filler neck 71 that receives a closure cap 72. The cap is apertured at 74 for air tight connection to the associated end of the hose H in any suitable manner, such as by a friction fit, bonding, cementing, etc. The bottle 70 is partially filled with water W, leaving an upper air chamber 75.

In order to admit atmospheric air into the air chamber 75 in response to the partial vacuum developed in the carburetor 16 during engine operation, an air inlet tube 76 is provided. The upper end of this tube makes an air tight connection to a fitting 77 secured to the bottle 70 and the lower end of the tube extends to the bottom of the bottle.

When the engine is running and the hose H is connected to the needle valve assembly hose nipple 62, air and water vapor are drawn from the air chamber 75 of the bottle 70 through the hose H. These gases flow through the needle valve assembly V and into the carburetor throat 16.

When the engine is running and the hose H is connected to the needle valve assembly hose nipple 62, air and water vapor are drawn from the air chamber 75 of the bottle 70 through the hose H. These gases flow through the needle valve assembly V and into the carburetor throat 16. The resultant pressure drop in the air chamber 75 causes atmospheric air to flow as make-up air into the air inlet tube 76 and to bubble up through the body of water W in the reservoir. This action maintains the gas pressure in chamber 75 at substantially atmospheric pressure and provides a source of air for the chamber 71 during engine operation. However, any fuel vapors that find their way back from the carburetor throat 16 to the

chamber 75 are trapped in the bottle 70 by the body of water W and will not be forced out of the tube 76 to the atmosphere.

Under circumstances wherein escape of fuel vapors to the atmosphere from the air bleed needle valve assembly V is not objectionable, no water trap T need be provided and no hose H is connected to the hose nipple 62 of the needle valve 70.

NEEDLE VALVE ASSEMBLY DETAILS

Referring to Figures 2 and 3, the needle N is threadedly attached to the inner plug 42 of the assembly V, in order that a specific needle may be selected from an assortment of needles designed for various carburetors and engines. As mentioned, the outer threaded portion 44 of the needle mates with the internal threads 46 formed at the carburetor idle chamber 30. The diameter and pitch of the outer threads 44 may vary from needle to needle, depending on the carburetor, but all needles have outer end attachment threads 80 of the same pitch and diameter. The inner plug 42 is counterbored and internally threaded at 82 to receive the needle attachment threads 80 and the needle is maintained in assembled condition with the plug 42 by a locknut 84.

As mentioned, the needle valve N is provided with an air bleed passage P. This passage is formed by drilling an axial bore 86 through the valve body and into the conical end 50. A radial bore 88 intersects the inner end of the axial bore 86. The diameters of one or both of the air bleed bores 86,88 are selected to minimize both fuel consumption and exhaust gas pollutant

emissions. The latter may be measured by analyzer tests during engine operation.

The tubular housing 40 is preferably formed from a metal having a good coefficient of heat conduction such as aluminum or an aluminum alloy. As best seen in Figure 3, the inner plug 42 is connected to the sleeve 40 by a crimping operation. The plug has a shallow groove 90 into which is crimped a bead 92 by deforming the wall of housing 40, with a conventional crimping tool. The resultant metal to metal joint facilitates conduction of heat absorbed by the housing 40 directly to the needle N and hence onto the wall portion 32 of the carburetor.

In order to mount the inner end of the heater element coil E, the inner plug 42 has a reduced diameter thimble 94 formed with a flared out surface 96 (Fig. 3). The inner end convolutions of the heater coil E are forced over the flared surface 96 of thimble 34 to make a snug electrical connection with the inner plug 42. This connection is made before the housing 40 and is slipped over and secured to the plug 42, as described above.

As seen in Figure 2, the outer plug 52 also has a flared projecting thimble 98 that snugly receives the outer end convolutions of the heater coil E in the manner described in connection with Figure 3.

In accordance with the preferred embodiment of the present invention, a metal shield tube ST extends between the end plugs 42,52 for conducting bleed air through the assembly V. As seen in Figure 2, the outer plug 52

has an axial bore 100 that receives the outer end of the shield tube ST with a light press fit.

In order that the resistance coil element E will provide the sole electrical connection between the plugs 42,52, even though the shield tube ST is formed of metal, the inner end of the shield tube is electrically insulated from the inner plug 42. This insulation is provided by a short insulating sleeve 102 (Figures 3 and 4) that is slipped over the inner end of the shield tube in a pre-assembly operation and which snugly embraces the shield tube. The thimble 94 of the end plug 42 is counterbored at 104 (Figure 3) to freely receive the insulating sleeve 102 during assembly. The inner end face of the insulated portion of the shield tube ST makes no contact with other parts and hence the shield tube does not provide an electrical short for the resistance coil element E.

In assembling the needle valve assembly V, one end of the heater coil E is forced over one of the plug thimbles and the insulation sleeve 102 on the shield tube ST is inserted in the counterbore 104 (Figure 3) in the thimble 94 of the inner plug 42. The other end of the wire coil E is now forced over the outer plug thimble T. The outer insulation sleeve S is next slipped over and along the outer plug 52 until its inner end abuts the inner plug 42. The tubular metal housing 40 is slipped over the insulating sleeve S and the underlying outer plug 52, until the inner end of the housing surrounds the inner plug 42, as shown in the drawings. The previously mentioned crimping operation to form

the crimp that secures the housing 40 directly to the inner plug 42 can now be performed.

As seen in Figure 2, the outer plug 52 is formed with a shallow groove 106 like the groove 90 formed in the inner plug, but the outer insulating sleeve S surrounds the groove 106. Thus, when the tubular housing 40 is crimped at 108 by the crimping tool, the outer plug 52 is secured in the tubular housing 40 with a length of the insulating sleeve S trapped between the plug and the housing. The resultant insulation of the outer plug 52 from the housing 40, the insulation of the shield tube ST from the inner plug 42 and the disposition of the insulating sleeve S around the wire coil E all insure that the coil E will provide the sole electrical connection between the outer plug 52 and the inner plug 42 which mounts the electrically grounded needle valve N.

Before the assembled valve V is fitted to a carburetor, a sturdy tubular outer fabric sleeve 110 is snugly fitted over the tubular metal housing 40. The outer sleeve 106 facilitates manual rotation of the assembly V for adjustment of the needle N in the carburetor wall, particularly when the heater coil E is energized and the tubular metal housing 40 has been heated.

After the needle N has been threaded into the carburetor with the spring 51 surrounding the needle, the electrical connector 58 is slipped over the connector nipple 60 and if a vapor trap assembly T is to be employed, one end of the hose H is slipped over the hose nipple 62.

EXAMPLES

By way of the specific examples, the diameter of the axial bore 86 or of the radial bore 88 forming the air bleed passages in the needle N, will be approximately 0.56 mm (0.020 inches) for a typical four cylinder engine of about 2 1/2 liter displacement. The corresponding diameters will be approximately 0.76 mm (0.030 inches) for an eight cylinder, five liter (305 cu. in.) engine. The shield tube ST has an external diameter of about 2.38 mm (3/32 inches) and a bore of about 1.59 mm (1/16 inches). The heater coil E is formed of nichrome wire of about 22 gauge or 0.635 mm (0.025 inches) diameter and has a resistance of about 4 ohms at 21°C (70°F) for 12 volts D.C. operation.

The insulating sleeves S and 102 are woven as tubes from fiberglass fibers, the tubes being commercially available under the trade name of Varflex, manufactured by the Varflex Company of Rome, N.Y..

The needle N, the end plugs 42,52, the housing 40 and the tube ST are formed of aluminum or of an aluminum alloy for good electrical and heat conduction.

OPERATION

When a needle valve assembly V of the present invention is originally installed, the original idle needle valve is replaced by a needle N of the present invention. This involves selecting and mounting a matching thread needle N on the inner plug 42. The selected needle N should have an air bleed passage P diameter suitable for the displacement of the engine, typical examples having been given previously. The

connector wire lead 54 is hooked up to the vehicle wiring system as indicated in Figure 1. If required by local regulations, a vapor trap assembly T including bottle 70 are mounted near the engine and the hose H is forced over the hose nipple 62.

The assembly V is adjusted with the engine running and with the heater coil E energized and at temperature. Optimum adjustment is obtained by the use of an engine exhaust gas analyzer and a tachometer, such as the analyzers manufactured by the Sun Electrical Corporation of Chicago, IL.

With the throttle closed, the basic criteria for optimum adjustment are maximum engine speed without engine "rolling" and without fuel starvation and stalling. If an engine analyzer is available, other criteria are the minimizing of emissions such as CO,Nx and hydrocarbon gases. As previously mentioned, it has been found by analyzing the results of operational tests employing the heated air bleed needle valve assembly of the present invention and an exhaust gas analyzer, that the reduction in emissions attained by simultaneously employing both the needle heating technique and the air bleed passage technique is greater than the reduction in emissions attainable by the separate use of either technique. More significantly, if the emission reductions attainable individually by the two techniques separately are combined to provide a statistically correct theoretical combination reduction figure (the product of the individual figures), the aforesaid operational tests have shown that the emission reduction attained by

applicant's double action needle assembly exceeds the reduction that would be theoretically provided if the aforesaid two techniques (heating and air bleed) were simultaneously employed.

If the water trap T is fitted, the gas drawn through the needle assembly V will contain water vapor. When no shield tube ST is provided, this gas dislodges particles from the insulating sleeve S. Any tendency of these dislodged particles to plug the air bleed passages P in the needle N is aggravated when the gas contains water vapor. The water vapor facilitates agglomeration of dislodged particles into a sort of paste, with the resultant plugging of the air bleed passage P.

By isolating the mixture of air and water vapor flowing through the needle valve assembly from the insulating sleeve S, the shield tube ST prevents the aforesaid entrainment of insulation member particles in the gases drawn through the air bleed passage P. Thus, the heated air bleed needle assembly V of the present invention will operate indefinitely without plugging, even though a liquid vapor trap T is employed. This result is not attainable if the shield tube ST is omitted. In fact, even if the needle valve assembly V is employed without the liquid vapor trap unit T, so that atmospheric air is drawn directly into the bore 100 in the shield tube, the shield tube ST insures that no particles of insulation material can accumulate in the needle air bleed passage P, even under highly humid atmospheric conditions.

MODIFIED FORMS

Figure 5 is a longitudinal section like that of Figure 2 showing a modified form of the invention. Since the only difference between the forms of Figure 5 and that previously described relates to the assembly of the shield tube, the reference numerals employed for the elements of the embodiment of Figures 1-4 are applied without change to the corresponding elements in the embodiment of Figure 5. However, where elements in the embodiment of Figure 5 have been modified, the subscript "a" has been applied to corresponding reference characters.

In the needle valve assembly Va of Figure 5 a metal shield tube STa is provided which serves the same function as the shield tube ST of the preferred embodiment, but in Fig. 5 the shield tube is insulated from the rear plug instead of from the front plug, as in Figure 2. In the embodiment of Figure 5 the bore 104a in the front plug 42a has a diameter that receives the shield tube STa with a light press fit. The bore 100a in the thimble 98a of the rear plug 52a has a diameter large enough to freely receive an insulating sleeve 102a that snugly embraces the rear end of the shield tube STa. Except for the physical transposition of the insulating sleeve from one end to the other end of the shield tube, the asssembly steps and the mode of operation of the embodiment of Figure 5 is like that described in connection with the preferred embodiment of Figures 1-4.

Figure 6 shows a similar modified form of the present invention wherein the shield tube is formed of

a nonconducting, heat resistant material. In the heated air bleed needle valve assembly Vb of Figure 6, as in the case of Figure 5, the elements of the assembly which are modified are given the same reference characters as those previously applied but with the subscript "b" applied thereto.

In the form of Figure 6 the shield tube STb is formed of a nonconducting, heat resistant material such as glass, sintered aluminum oxide or a heat resistant thermosetting resin. Neither end of the shield tube STb need be insulated from its associated end plug, so that the bores 104b in the front plug 42b and 100b in the rear plug 52b receive the associated ends of the shield tube directly without need for an insulating sleeve, as before. The shield tube STb of Figure 6 has a nice sliding fit in the bores 104b,100b and end stop shoulders are provided for axially locating the shield tube. The general principals of assembly and mode of operation of the form of the invention shown in Figure 6 are like those previously described.

NEEDLE ASSORTMENT

The needle N (Figs. 1-3) has mounting threads 80 of a standard diameter and pitch, eg 10/32. The carburetor threads 44 have a larger diameter and a finer pitch, eg 1/4"/36.

Figures 7 and 8 show two additional examples of assorted needles which are constructed to fit the carburetor for a given engine but each of which can be mounted on a single master needle valve assembly V, Va or Vb in accordance with the present invention.

The needle Na of Figure 7 is like the needle N previously described except that the diameter and pitch of threads 44a that are received by the body of the carburetor C are identical with the diameter and pitch of the standard mounting threads 80 that mount the needle in the inner plug. In other words, the needle Na of Figure 7 is uniformly threaded along its length. In the embodiment illustrated the mounting threads 80 are size 10/32 for all needles.

The needle Nb of Figure 8 has threads of uniform basic diameter along its length but in this needle the carburetor threads 44b are of a finer pitch (eg 10/40) than are the standard needle mounting threads 80 (10/32), previously described.

Having completed a detailed description of several embodiments of my invention so that those skilled in the art may practice the same, it can be seen that I have disclosed heated air-bleed needle valve assemblies which improve fuel economy, reduce exhaust emissions, can be selectively connected to a liquid fuel vapor trap, which will operate indefinitely without plugging of the air bleed passage running through the jet needle, and which can be fitted with any one of an assortment of threaded needle valves.

CET:lw

I claim:

1. An adjustable idle needle valve assembly for controlling the aspiration of idling fuel into the throat of an internal combustion engine carburetor at a zone downstream of the throttle valve, said assembly comprising a threaded metal needle valve, an elongate tubular metal housing, inner metallic plug means for said tubular housing connected to the outer end of said needle valve, outer metallic plug means for said housing, means for insulating one of said plug means from the housing, a tubular electric insulating sleeve within said housing, a helical heating coil of resistance wire within said insulating sleeve connected between said outer and inner plug means, and means for providing an electrical connection to said outer plug means for energizing said coil; the improvement wherein said needle valve has an air bleed passage extending axially from its outer end to a transverse passage at its inner end, an axial air passage in said inner plug means communicating with said needle valve passage, an air inlet passage in said outer plug means, a small diameter air conducting shield tube extending between said outer and inner plug means and communicating with the air passages therein, said coil of resistance wire providing the sole electrical connection between said outer and inner plug means, and an air line connection on said outer plug means for selectively connecting said plug means to an air inlet vapor trap.

2. The needle valve assembly of claim 1; wherein said shield tube is formed of metal and means for electrically insulating one end of said shield tube from one of said plug means.

3. The needle valve assembly of claim 2; wherein the other end of said shield tube is mounted directly to the other of plug means.

4. The needle valve assembly of claim 2; wherein the air passage in said one plug means has a portion that is larger in diameter than the diameter of said one end of the shield tube, said shield tube insulating means comprising an insulating sleeve surrounding said one end of the shield tube and disposed in said larger diameter portion of the inner plug means passage.

5. The needle valve assembly of claim 4; wherein said shield tube insulating sleeve is a fiber glass fabric.

6. The needle valve assembly of claim 4; wherein said shield tube is mounted directly in the air passage of said outer plug means with a light press fit.

7. The needle valve assembly of claim 1; comprising a liquid reservoir air inlet vapor trap and air conduit means detachably connected between said vapor trap and the air line connection on said outer plug means.

8. The needle valve assembly of claim 7; wherein said electrical connection means comprises a connector clip detachably connected to said outer plug means between said air line connection and said housing.

9. The needle valve assembly of claim 1; wherein the inner portion of said inner plug means is formed with a threaded socket communicating with the air passage in said inner plug means, the outer end of said needle valve being externally threaded and screwed into said socket for facilitating attachment of any one of an assortment of needle valves to said inner plug means and a locknut for the external threads on the outer end of said needle valve.

10. An adjustable idle needle valve assembly for the carburetor of an internal combustion engine, said assembly being of the type having a threaded needle valve with an air bleed passage therethrough, an electric heater unit comprising a tubular housing, inner plug means for connecting the inner end of said housing to the outer end of said needle valve, electric terminal plug means for the outer end of the housing, means for insulating one of said plug means from the housing, a helical electric heating coil within said housing connected between said plug means for heating said needle valve, an electric insulation sleeve surrounding said coil, an air bleed passage through each of said plug means and a hose nipple on said electric terminal plug means; the improvement comprising a small diameter metallic air conducting shield tube, means for mounting said shield tube between said plug means and in com-

electrically insulating said shield tube from one of said plug means to prevent shorting out of said heating coil by said shield tube and means for selectively connecting the hose nipple on said electric terminal plug means to a vapor trap.

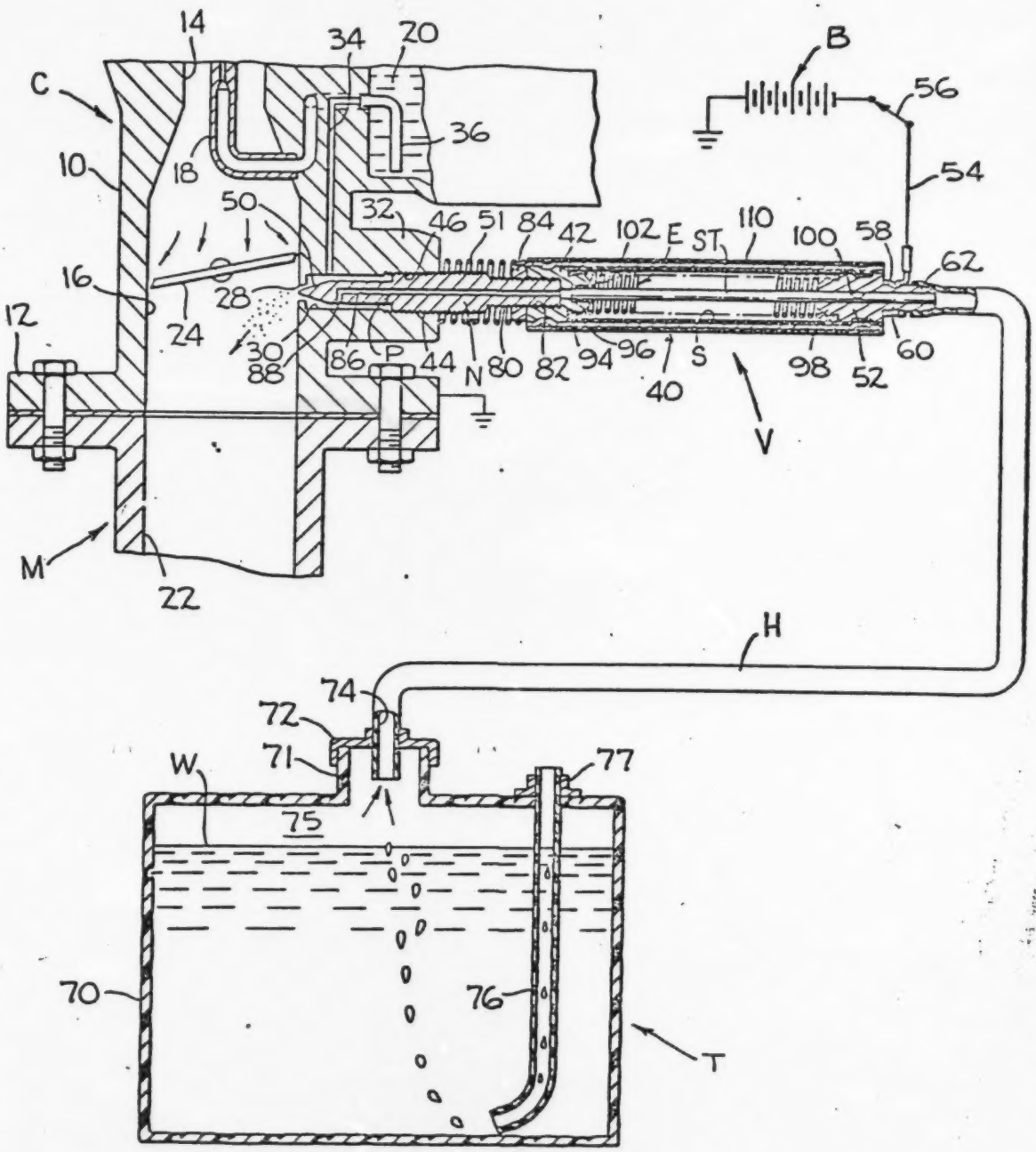
11. The assembly of claim 10; wherein said shield tube insulating means comprises an insulating sleeve disposed between an end of the shield tube and the associated plug means.

CET:lw

ABSTRACT OF THE DISCLOSURE

An adjustable idle needle valve assembly for an internal combustion engine carburetor includes an air bleed threaded needle valve mounted on a plug for a tubular metal housing, an insulating fiberglass sleeve in the housing and an electric needle valve heat coil within the insulating sleeve. The heater coil extends between the needle valve mounting plug and an outer air inlet plug for the tubular metal housing. An air-conducting shield tube extends between the plugs for isolating the flow of bleed air from the insulating sleeve, particularly when the outer plug is connected to a liquid vapor trap.

Fig. 1


14
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20
B
C
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36
10
18
54
50
32
46
51
84
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E
ST
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58
62
16
28
12
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30
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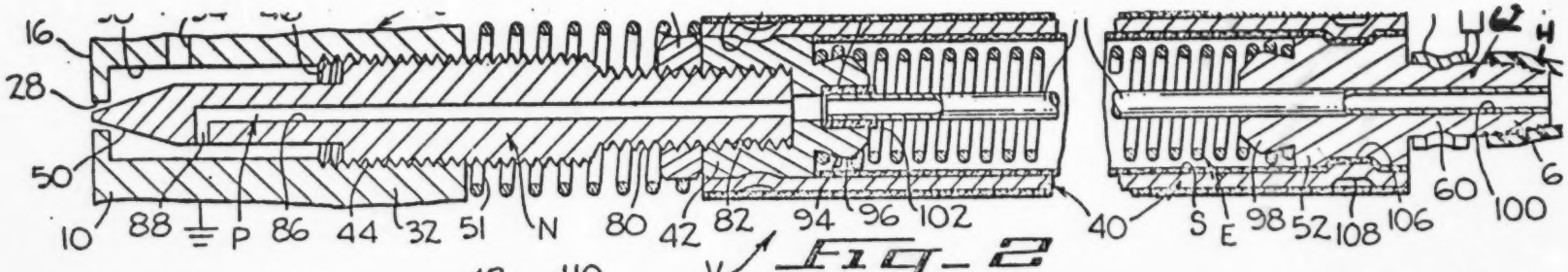


Fig-2

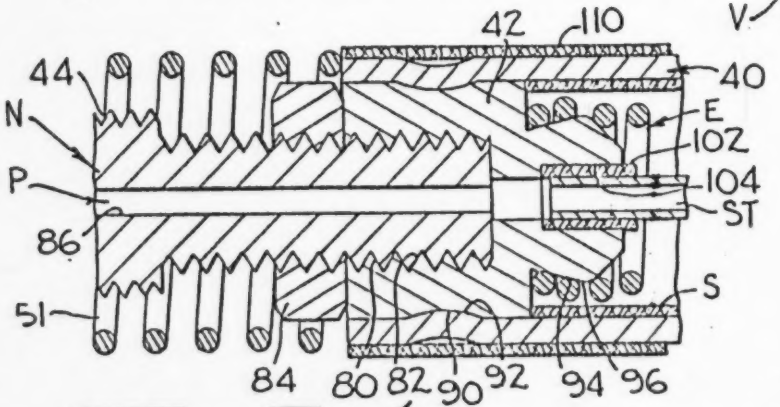


Fig-3

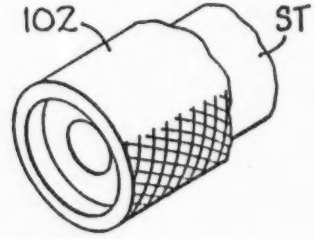


Fig-4

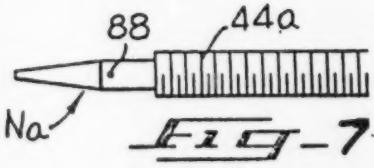


Fig-7

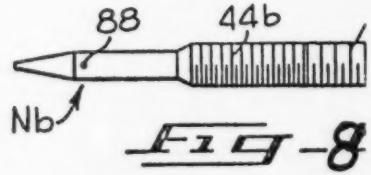


Fig-8

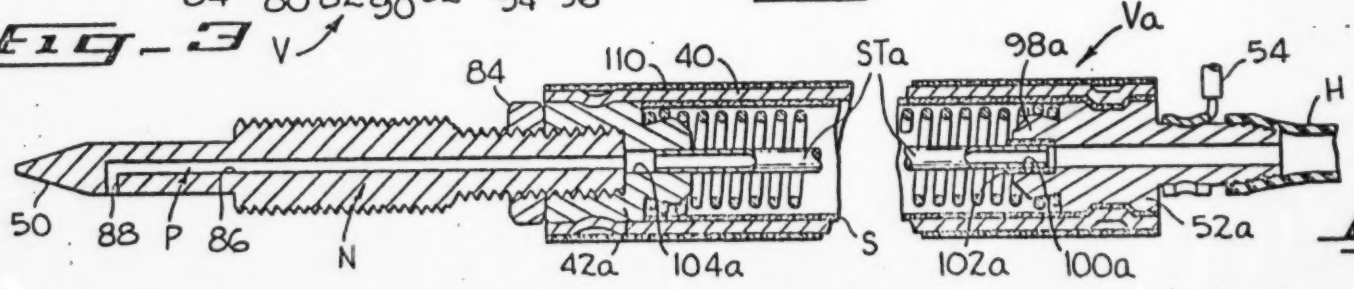


Fig-5

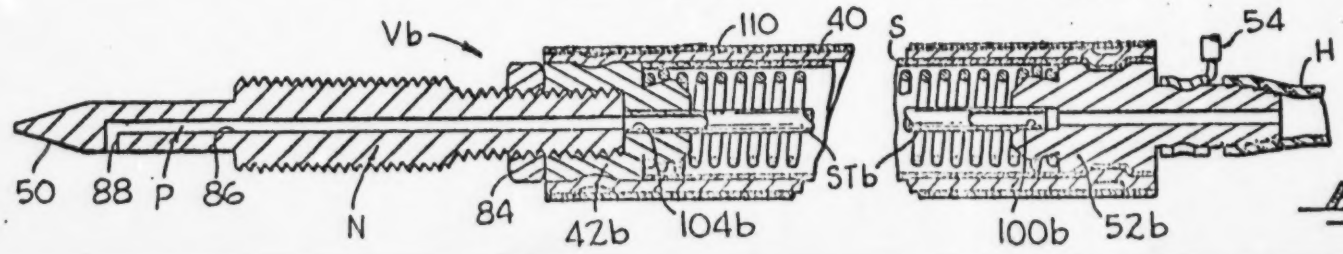


Fig-6

SCI
ENVIRONMENTAL ENGINEERING
DIVISION

In reply refer to:
413-81-213
Project #7801-019

September 4, 1981

Mr. Jack Passey
Freedom Products, Inc.
P.O. Box 700
Freedom, CA 95019

Subject: Test Results of Jet Heater

Dear Mr. Passey:

Systems Control, Inc. (SCI) performed emissions and fuel economy tests in accordance with procedures specified by the Environmental Protection Agency. The tests performed were duplicate LA-4 driving cycles and an SH cycle for each of three different configurations. The LA-4 driving cycle is the cold transient and cold stabilized portion of the Federal Test Procedure (FTP). The SH cycle consists of a 3-minute cruise at 50 mph followed by identical back-to-back Highway Fuel Economy Tests (HFET).

The three vehicle configurations were as follows:

Test 1) Baseline with vehicle adjusted to factory specs.

Test 2) Vehicle with "Jet Heaters" installed and adjusted to Freedom Products Recommendations.

Test 3) Vehicle with stock idle mixture screws installed and idle mixture adjusted to give smoothest idle with highest manifold vacuum.

The LA-4 driving cycle includes accelerations, decelerations, idles, and cruises. The maximum speed driving is approximately 55 mph and the average speed is approximately 25 mph. The driving cycle is performed on a chassis dynamometer and represents typical driving. Emission data repeatability is usually ±20 percent. Fuel economy repeatability is usually ±5 percent.

Tests were performed on a 1978 Chevrolet Monte Carlo with a 305 cu. in. V-8 engine, automatic transmission, air conditioning and with 63,000 miles accumulated. All three tests were performed using a 3,500 pound inertia and 10.7 road horsepower.

The results of the tests are as follows:

	EMISSIONS (GRAMS/MILE)				FUEL ECONOMY	
	HC	CO	NO_x	CO_2	LA-4	HFET
Test 1 - Vehicle Factory Specs	0.655	7.5	0.782	569.9	15.21	21.05
Test 2 - With "Jet Heaters"	0.660	11.58	0.728	571.8	15.06	20.98
Percent of Change	0.7	54.4	-6.9	0.3	-0.9	-0.3
Test 3 - Veh. Adj. to Best Idle	1.748	39.72	0.778	555.6	14.23	21.03
Test 2 - With "Jet Heaters"	0.660	11.58	0.728	571.8	15.06	20.98
Percent of Change	-62.2	-70.8	-6.4	2.9	5.8	-0.2

$$\text{Percent Change} = \left(\frac{w\text{-}w/o}{w/o} \times 100\%\right)$$

In addition to the driving cycles, another idle test was performed measuring emissions with the infrared analyzer. Two measurements were taken. One with the vehicle in Test 2 configuration. The other was with the vehicle in Test 3 configuration. The results are as follows:

	IDLE RPM IN DRIVE	CO %		HC PPM		VACUUM
		EO	TP	EO	TP	
With Stock Idle Jets	500	3.4	2.6	230	230	16.4"
With "Jet Heaters"	500	1.4	.75	180	160	16.2"

EO = Engine Out (Ahead of Catalytic Converter)
TP = Tail Pipe (After Catalytic Converter)

The results show that compared to a vehicle that is adjusted to factory specifications the "Jet Heaters" increases the CO emissions with no significant change in either urban or Highway Fuel Economy.

However, compared to a vehicle that is adjusted out of specification but to "Best Idle," the "Jet Heater" significantly reduces both HC and CO emis-

If you have any questions please feel free to call me or Dick Carlson at (714) 956-5450. We are returning the "Jet Heaters" separately.

Sincerely yours,

SYSTEMS CONTROL, INC.
Environmental Engineering Division

Gary Leonhardt

Gary Leonhardt
Project Engineer

GL/jp

cc: R. Carlson
F. Labun
P. Meyer
T. Thurman
Contracts

FREEDOM PRODUCTS INC.
P.O. BOX 700
FREEDOM, CA 95019

JET-HEATER.

408-~~722-4933~~
728 4738

Jan 4, 1982

Mr Tony Bartl
U.S. EPA
Ann Arbor, Mich

Dear Tony,

Enclosed herewith are the additional documents, papers and drawings that you requested for my 511 application. The drawings indicate the difference in the method of admitting the air into the needle as per our discussion on the telephone.

The instructions for installation are included on the yellow brochure as well as the suggested list price. Installation should cost not more than $20.00

At the present time we are doing our own marketing, but hope to interest one or two large retail chain stores. We are presently working in that direction.

Please let me know if I can do any thing more to assist in your evaluation of the device.

Sincerely,

Jack Passey Jr

Reproduced from best available copy.

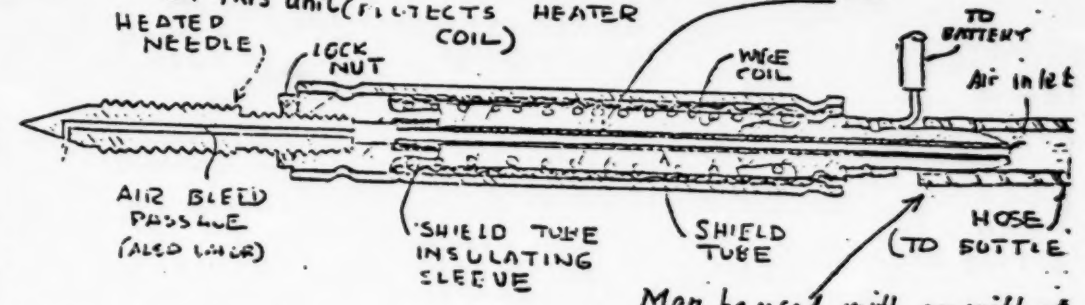
JACK PASSEY JR
FREEDOM CALIF

Jack Passey, Jr
425 Hecker Pass Rd
Watsonville Ca. 95073

...CE SHOW IN
.215 417

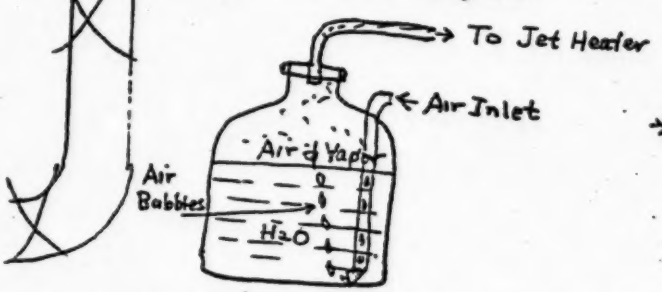
PREFERED NEEDLE
WITH INSULATED AIR
+ VAPOR SHIELD TUBE

Patent applied for
on this unit (PROTECTS HEATER COIL)



May be used with or without
(B) H_2O Vapor Bottle. Vapor Bottle
filters air and keeps fumes from
entering atmosphere

Vapor Bottle Diagram:

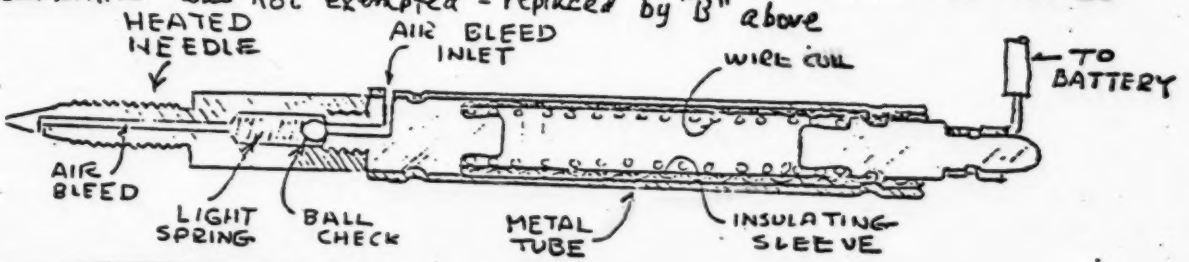


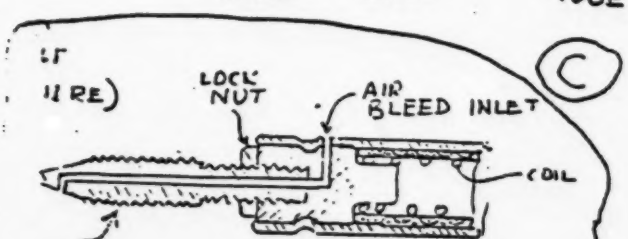
* Tests of Units "B" and "D" produce
the same results when vapor bottle
is not used on "B."

Future plans are to make tests
with "B" wing bottle. I feel it is the best

This unit designed for
California - was not exempted - replaced by "B" above

MODIFIED NEEDLE - WITH CHECK VALVE TO PREVENT ESCAPE OF FUMES





(C) — NO WATER VAPOR

(D) — NO WATER VAPOR

This method of Air Bleed used in test

CE Trapp
Los Gatos, Calif
9/9/81

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ANN ARBOR, MICHIGAN 48105

OFFICE OF
AIR AND WASTE MANAGEMENT

January 19, 1982

Mr. Jack Passey Jr.
425 Hecker Pass Rd.
Watsonville, CA 95076

Dear Mr. Passey:

On December 8, 1981, we received your letter dated November 24, 1981 in which you applied for an EPA evaluation of the "Freedom Products Hot Tip", an emissions/fuel economy device. We notified you on December 10 that page 3 of the application was missing. We received page 3 on January 7, 1982.

Our Engineering Evaluation Group has made a preliminary review of your application. Based on this review, our phone call to you on December 10, and the information provided in your letter of January 4, we have identified several areas that require additional clarification prior to further processing of your application. Our comments below address the individual sections of your application.

1. Section No. 2 - Marketing Identification

   Several different variations of this device (heated idle mixture screw) were described. They are:

   a. Freedom Products Hot Tip of your application. It incorporates both a long internal and a short external air bleed.

   b. Preferred needle B of your January 4 letter. It incorporates a long internal air bleed.

   c. Preferred needle B of your January 4 letter with vapor bleed. It incorporates a long internal air bleed through a vapor bottle.

   d. Modified needle C of your January 4 letter. It incorporates a short internal air bleed with a check value.

   e. Needle D of your January 4 letter. It incorporates a short internal air bleed.

   f. Freedom Products Jet Heater of your January 4, letter. It apparently has no air bleed.

   From the correspondence and our telephone conversations, it is not clear exactly to which variation your application applies. Please specify which device or devices are covered by your application. Also your application does not distinguish between units with SAE or metric screw threads. Other literature suggests that both are available. Do you market SAE and metric versions? If so, how are they identified? How many different models of your product are required to cover the range of applications?

2. Section 3 - Identification of Inventor/Patent Protection.

   In our discussion of December 10, you stated that Appendix 1 - (copy of the patent) referred to an earlier device and was submitted for background information purposes only. Is this correct? This patent appears to describe the Jet Heater. Is this correct?

   In our discussion of December 10, you stated that Appendix II - (Description of Unit) was also a copy of the new patent application and that this was the device being submitted for evaluation. Is this correct?

3. Section 8 - Description of Device

   The description of the unit (Appendix II) is presumed to apply to the device indicated in Section 2 of the Application. This appears to be what I have identified in item 1 above as a. Freedom Products Hot Tip incorporating long internal and short external air bleed. Is this correct?

4. Section 9 - Applicability

   You stated that the device can be used on essentially all vehicles with unsealed idle mixture screws. Many vehicles manufactured during the past several years have had features to discourage tampering with the idle mixture. Your non-air bleed units apparently incorporated a limiter function to prevent tampering. Does the device applied for have a similar anti-tampering feature? If yes, please describe.

5. Section 10 - Installation Instructions

   The installation instructions provided in the application and your letter of January 4 appear to apply only on a non-air bleed idle mixture screw heater - the Freedom Products Jet Heater - and not to the device applied for which this application was submitted. Is this correct? These instructions appear incomplete for any of the air bleed devices noted in item 1 of this letter. Is this correct? Please provide detailed installation and adjustment instructions for the device which you identify in item 1 above as the device for which you are requesting an evaluation.

6. Section 12 - Maintenance

   You state that the device requires no maintenance. However Appendix II, pages 7 and 8, indicate that maintenance is required. Please explain.

7. Section 15 - Test Results

   The test results appear to be for device identified in Item 1 above as Needle D. Is this correct?

8. What are the specific emission and fuel economy claims to be made for your device?

9. How will the device be marketed. You stated on December 10 that marketing was to be done principally through tune-up shops. However, your letter of January 4 stated that you currently market the device yourselves but are now attempting to market the device through retail chains. Please clarify.

10. Are any of the required installation parts (wires, electrical connectors, etc.) included with the device . If yes, please specify what is included.

11. On December 10, you stated that the price of the device was $59.95 and should be able to be installed for about $20.00. This appears to be for the non air-bleed Jet Heater. Do the same prices apply for the various air-bleed heaters?

Submittal of the information requested above will be necessary to further process your evaluation. In order to process applications efficiently, we establish a schedule for each one. I ask that you respond to this letter by February 10. If you have any questions or required further information, please contact me (313) 668-4299.

Sincerely,

Merrill W. Korth
Device Evaluation Coordinator
Test and Evaluation Branch

mfg
FREEDOM PRODUCTS INC.

P.O. BOX 700
FREEDOM, CA 95019

408-~~722-4933~~
728-4738

Febraury 19, 1982

Mr. Merrill W. Korth
U.S. Environmental Protection Agency
Anr. Arbor, Michigan 48105

Dear Mr. Korth:

In response to your letter of January 19, 1982, I will answer each question in the order they are presented. I am also enclosing a copy of the patent which has been submitted to the United States patent office.

1. Section No. 2 - Marketing Identification

   a,b,c The Freedom Products Hot Tips B incorporates the long internal and short external air bleed tube as per the enclosed patent application. This is the device we want to have tested and want to market. The long internal air bleed heats the air better then the short air bleed,but its main purpose is to enable us to filter out particulates and to prevent the bleed back of vapor after the engine is stopped by use of the vapor bottle or filter bottle as it may also be called. In states such as California, I believe the filter bottle would be a necessity. If other states that don't have a pollution problem would permit it the device car also be used without the bottle.

   d. Modified Needle C with the check valve was submitted to the California Air Resources Board. It's purpose was to prevent the bleed back of vapors. The A.R.B. denied us an exemption because it admits particulates from the atmosphere into the engine. It is also more cumbersome to install so we have rejected it.

   e. Needle D with the short internal air bleed is the style that was used for testing to check the feasibility of using an air bleed. It is not to be considered in future testing or marketing.

   f. Freedom Products Jet Heater does not, as you have noted, have an air bleed. It is the device that we have, California Air Resources Board exemption #D109 on at present. We have sold these in California. The "B" needle works about 50% better and we would like to replace the solid needle with it which is the reason for this application.

53

The application does not distinquish between SAE and metric screw threads because the heater units all have the same 10-32 internal threads. The needles all have the same threads on the shank that screws into the heater and is locked in place with a lock nut, but the body of the needle that goes into the carburetor may have many different sizes, shapes and threads. They are identified by the model of the carburetor in which they are to be installed. We presently have needles to cover the more popular Carter, Ford and Rochester carburetors as well as the most common Japanese carburetors. We are working on Holley and have developed one main needle at present for it, with additional ones to be added.

2. Sections 3- Identification of Inventor/Patent Protection

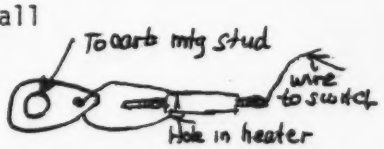
Appendix I is the Jet Heater or the needle in "f" above. Appendix II is a Copy of a patent application involving the air bleed, but the enclosed new patent application is to take it's place and is the device being submitted for evaluation.

3. Section 8- Description of Device

Yes, the Freedom Products Hot tip is the one identified in item I as "a" but with the description as in the new Appendix II as mentioned above.

4. Section 9- Applicability

The device can be made tamper proof by drilling a small hole near the needle end and running a wire through the hole and installing a lead seal between the two heaters. On single application a stamped part as illustrated here is installed under a carburetor flange mounting nut and wired to the heater.



5. Section 10- Installation Instrustions

The installation instructions for the solid needle and the Hot Tip with air bleed are virtually the same. The Hot Tip usually has to be backed out a little more, because of the air bleed, to get a smooth idle. The addition of the vapor or filter bottle would require a simple diagram showing a vacuum line from the heater end to the bottle. The bottle is mounted on any available space under the hood with a bracket held on by sheet metal screws.

6. Section 12-Maintenance

The only maintenance that is required is the same as for any carburetor in that continued usage causes carbon build up in the idle circuit. If it gets plugged up as with a stock idle screw it may have to be removed for a regular carburetor cleaning job. The electrical part has 100% safety margin against burn out and we have never had a failure so far.

7. Section 15- Test Results

   Yes, the test was conducted using needle D.

8. The reduction in emmisions and improvement in fuel economy have varied depending on the condition of the engine and especially the carburetor. Individual driving habits are also a factor. On cars without serious problems we have dropped emissions from 25% to 75%. Mileage increases have been from very little to 20%.

9. The marketing of the device is the most difficult problem to solve. I have interviewed promoters,brokers, wholesalers, retailers and have been approached by two large corporations interested in an out right purchase. I believe the device should be sold through qualified shops since the best results are obtained when infra-red equipment is used for adjusting the needles. It is not impossible for good mechanics to install them by "ear", but I don't believe the average "back yard" mechanic could achieve maximum benefits. Therefore I prefer to see them installed with the use of equipment. It is also extremely beneficial to check the air cleaner, to make sure the carburetor float is set correctly and to check to see that the ignition system is in order. The infra-red machine can give an immediate clue is the carburetor float is not operating correctly.

10. A wiring harness is included with each set and includes a 9 amp fuse and holder.

11. The price of the Hot Tip Heater may be adjusted to $79.95 as it is more costly to manufacture. The installation should cost the same if no vapor bottle is used and some shops may possibly want $25.00 if the bottle is used. The $20.00 installation is an average cost. Some heaters, as on a Courier, can be installed in half the time and should not cost as much.

Thank you for the opportunity to answer these questions. I will look foward to hearing from you after you have looked over the information.

Sincerely,

Jack Passey

Jack Passey Jr.
President of
Freedom Products

Jack Passey, Jr.
425 Hecker Pass Rd.
Watsonville, Ca 95076

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ANN ARBOR, MICHIGAN 48105

March 9, 1982

OFFICE OF
AIR, NOISE AND RADIATION

Mr. Jack Passey, Jr.
425 Hecker Pass Road
Watsonville, CA 95076

Dear Mr. Passey:

The purpose of this letter is to confirm the items discussed in your letter of February 19 and clarified in our telephone conversation of February 24. We are also providing you with a suggested test plan which you can use at an independent laboratory to evaluate the "Hot Tip".

Following is a summary of what we understand from recent communications:

1. Appendix I to your application of November 24, 1981 described an earlier device. It was submitted for information only and does not apply directly to your application.

2. Appendix II of your application described a model with an unshielded long internal air bleed with undercut threads providing an external air bleed. The application no longer applies to this model.

3. The copy of the patent enclosed with your letter of February 19 describes the device to which your application applies. It incorporates a shielded, heated, long internal air bleed. This model can be used with or without a vapor bottle.

4. The air bleed of the needle is preset. There is no clamping of an attached bleed hose either to check out, install, or adjust the air flow through the bleed. The only adjustment is by the turning of the threaded needle in the carburetor body.

5. The application currently covers the model without the vapor bleed. You were unsure as to whether the application should also cover the vapor bleed version. Please inform me if the vapor bleed model is to be included in the application.

6. The installation instructions in your application apply to the device now described as having no vapor bleed.

7. If you decide the vapor bleed model should be included in your application, please provide the installation and operating instructions for it. Be sure to include instructions about refilling the reservoir.

8. For the vapor bleed model, you were unsure of the water level. What is the height in inches of the water level in the bottle above the submerged end of the air inlet tube?

9. The electrical load of a single needle is still the 2 1/2 amps quoted in your letter of January 4.

10. From a standpoint of electrical loads on the vehicle, there are no problems associated with hooking up two needles to the ignition switch.

11. The test data submitted with your application was for the model D (of your January 4 letter) which had a short external air bleed. The application does not apply to this model.

We now believe we have sufficient information so that we can assist you in developing a test plan for your use at an independent laboratory. Enclosed is a family of general test plans which can be used in evaluating your device. It appears that test plan code A (no parameter adjustments and no mileage accumulation required) using test sequence code 4 (claims for device on city and highway, device does affect cold start) would be the most appropriate Test Plan/Test Sequence to use. On the other hand, Test Sequence code 1 (claims for device on city and highway, and device does not affect cold start) would also be acceptable to us and would cost less.

For test plan A, the baseline test is conducted with the vehicle adjusted to manufacturer's specifications, not "best idle". Since you previously indicated that you felt best idle should be the baseline, you may wish to add parameter adjustment tests by using test plan code B. However, this will increase the number of tests on each vehicle and add to the cost of the testing.

Your letter of February 19 indicated you expect the fuel economy benefits to vary between 0% and 20% based on your road test experience. If a similar level of vehicle-to-vehicle variability is encountered in the laboratory tests, you will need to test a number of vehicles. For example, if the average fuel economy improvement achieved in testing the device is less than 5%, you will need to test more than three vehicles to verify the fuel economy improvement.

In order to minimize the potential costs, you may wish to test vehicles sequentially rather than as a group. On this basis, you could initially test two or three vehicles. If the test results are not conclusive, you could schedule another complete test sequence on additional vehicles, one at a time.

Also, please note that the number of individual tests required by a given Test Plan and Test Sequence refers to the number of valid tests on a vehicle that is in proper tune when tested.

Since I would expect the results to differ between your basic model and the one with the vapor bleed, it will be necessary to test each configuration separately. To minimize the test requirements, the same vehicle fleet could be used for both configurations and it would not be necessary to rerun a second set of baseline tests. The tests on the vapor bleed model could immediately follow tests on the basic model.

I am prepared to assist you further in the development of your test plan. Please inform me of your progress by March 22. If you have any questions or require further information, please contact me.

Sincerely,

Merrill W. Korth

Merrill W. Korth, Device Evaluation Coordinator
Test and Evaluation Branch

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ANN ARBOR, MICHIGAN 48105

OFFICE OF
AIR, NOISE AND RADIATION

April 12, 1982

Mr. Jack Passey, Jr.
425 Hecker Pass Road
Watsonville, CA 95076

Dear Mr. Passey:

Since I haven't heard from you recently, I am writing to determine the status of your test program on the "Hot Tip". In your telephone response to my letter of March 9, you stated that you intended to negotiate with other independent laboratories. You also promised to supply several pieces of information that we still have not received.

In my letter I suggested that Test Plan A, using Test Sequence 1 or 4, appeared to be the most appropriate test plan. I also commented on the idle adjustments. Please provide a copy of the test plan you expect to use and tell me which laboratory you have chosen and when the testing is scheduled.

Again, I am prepared to assist you in the development of your test plan. Please let me know of your progress by April 23. If you have any questions or require further information, please contact me.

Sincerely,

Merrill W. Korth
Device Evaluation Coordinator
Test and Evaluation Branch

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

ANN ARBOR, MICHIGAN 48105

May 27, 1982

OFFICE OF
AIR, NOISE AND RADIATION

Mr. Jack Passey, Jr.
425 Hecker Pass Road
Watsonville, CA 95076

Dear Mr. Passey:

We still lack appropriate test data to support your claims for your "Hot Tip". As I explained in our earlier letters and telephone conversations, we are obligated to publish our evaluation in the Federal Register. We cannot delay that action indefinitely and have begun to prepare our evaluation. Therefore, I must ask you again to provide the information we need or we will have to complete our evaluation and publish our conclusions with the information at hand.

We have yet to see your plan for the test program you are planning to undertake. As we explained, if we do not have the opportunity to review your plan, you run the risk of an oversight that might invalidate your whole effort. We recognize that such testing is expensive and want to ensure that your testing will meet our needs.

Because of the inordinate amount of time that has passed since we first received your application and the difficulties encountered in getting the information for us to analyze, we are faced with the need to establish a deadline. That deadline is July 2. At that time, we will conclude our evaluation, with or without the requested information. We believe that that date allows enough time for our review of your plan and the conduct of the program at an independent laboratory. As we stated previously, at least two or three vehicles should be tested. If the data from the independent laboratory indicate a meaningful fuel economy or emissions benefit, EPA may perform confirmatory tests.

Please let us know when you send us the test plan what laboratory you have selected and the scheduled dates for your testing. If you have any questions about our requirements, please contact me immediately at (313) 668-4299.

Sincerely,

Merrill W. Korth, Device Evaluation Coordinator
Test and Evaluation Branch